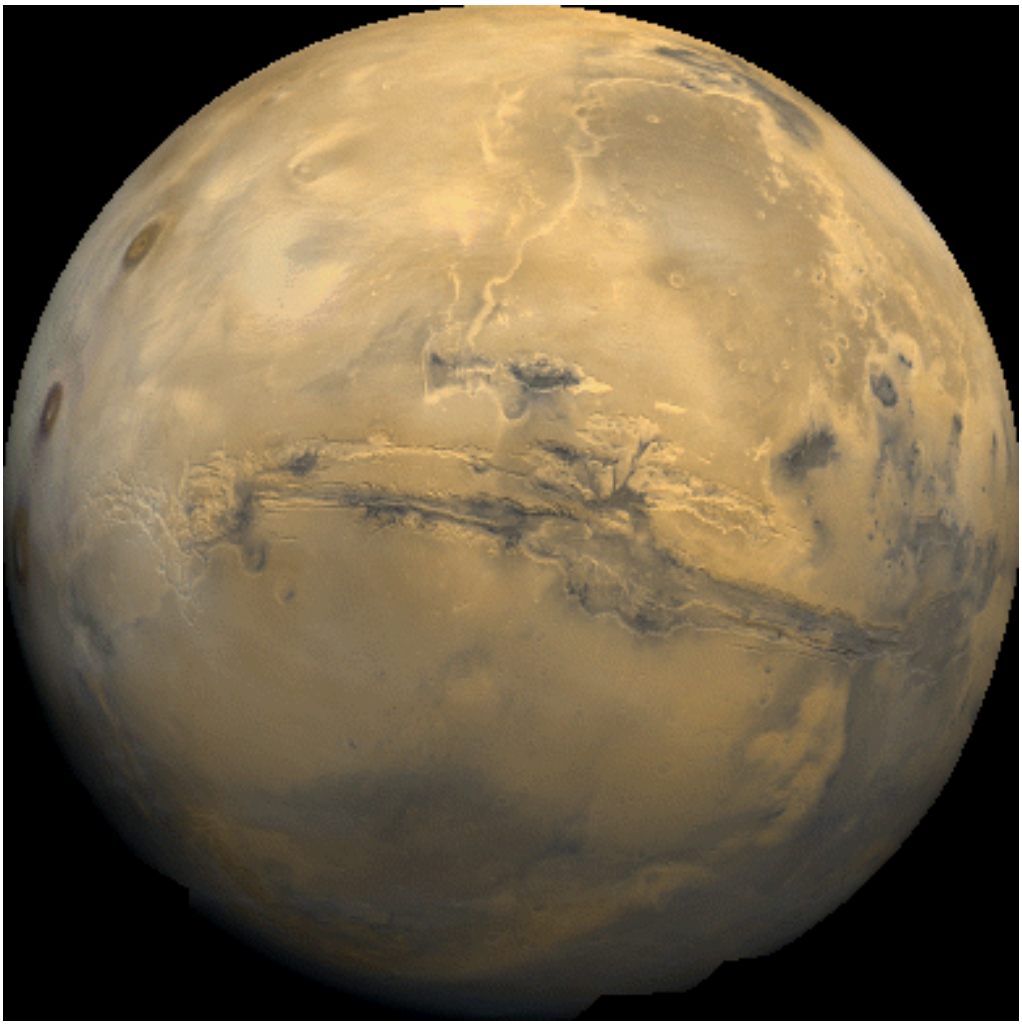
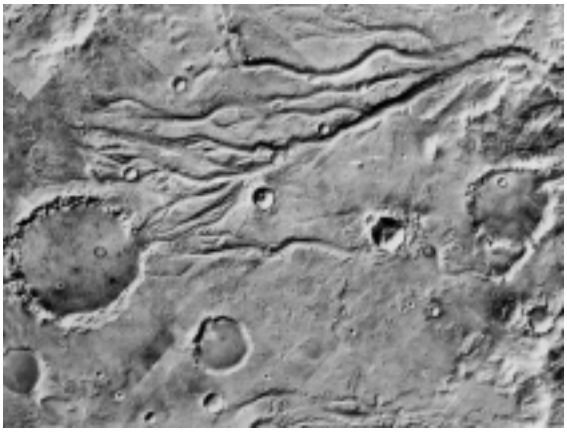
MARS



Lesson 5 - Interpreting Images of Other Planets

USGS
science for a changing world
Astrogeology Research Program



Interpreting Images of Other Planets

Grade Level: 6th –12th

Objectives:

- Recognition and identification of surface features using digital images
- Understanding the effects of sun angle and direction in digital images

Arizona State Standards:

- **1SC-P3.** Analyze and evaluate reports of scientific studies. **PO 1.** Analyze reports of scientific studies for elements of experimental design
- **1SC-P1.** Propose solutions to practical and theoretical problems by synthesizing and evaluating information gained from scientific investigations. **PO 1.** Evaluate scientific information for relevance to a given problem

Time needed: 1 class period

Introduction:

Because scientists cannot do actual fieldwork on other planets, they must rely on **remote sensing** instruments to gather data. One such instrument is the Mars Orbiter Camera (MOC) onboard the Mars Global Surveyor spacecraft. MOC is a camera that takes very **high-resolution** black and white images of the surface of Mars. The image is recorded as a grid of information. Each square of the grid is called a **pixel**. The grayscale value of each pixel is recorded as a number. Each number is assigned a unique brightness value, from white to black, with shades of gray in between. These numbers, 0 through 255, are then coded into radio pulses and sent to receiving antennas on Earth. Computers interpret these signals and convert them into an array of numbers in rows and columns to form a digital image or picture. The result is a black and white picture or a **digital image**.

Viewed together, pixels and then images comprise a mosaic depicting the surface of a planet. They can show geologic features. The brightness of each pixel varies depending on how much sunlight is reflected off the surface. Steeper surfaces and slopes are usually brighter than flat surfaces. However, brightness depends primarily on the position, or angle, of the sun in the sky when the surface is imaged. The lower the sun the brighter some features can be because they are receiving more direct rays of sunlight. Also, a lower sun angle makes longer shadows. Think about the difference in a person's shadow length when the sun is low on the horizon and again when it is directly overhead at noon. When it is low on the horizon the person's shadow is quite long. However, if the sun is directly overhead the person will have little or no shadow at all. This same phenomenon occurs when sunlight reflects off any object, including features such as mountains, canyons, impact craters and volcanoes on the surface of a planet.

Sun angle is a very important factor when interpreting digital spacecraft images. Therefore, every image includes information about where the sun was when the image was taken. In a single image, sunlight will be coming from the same direction. Parts of a feature that are directly opposite the sun will get the most light. For example, if one side of a mountain range is dark and the other is bright, which direction would the sunlight be coming from? See the figures below *(also shown in Overhead 1)*.

Figure 1. Example of sun angle on a mountain range.

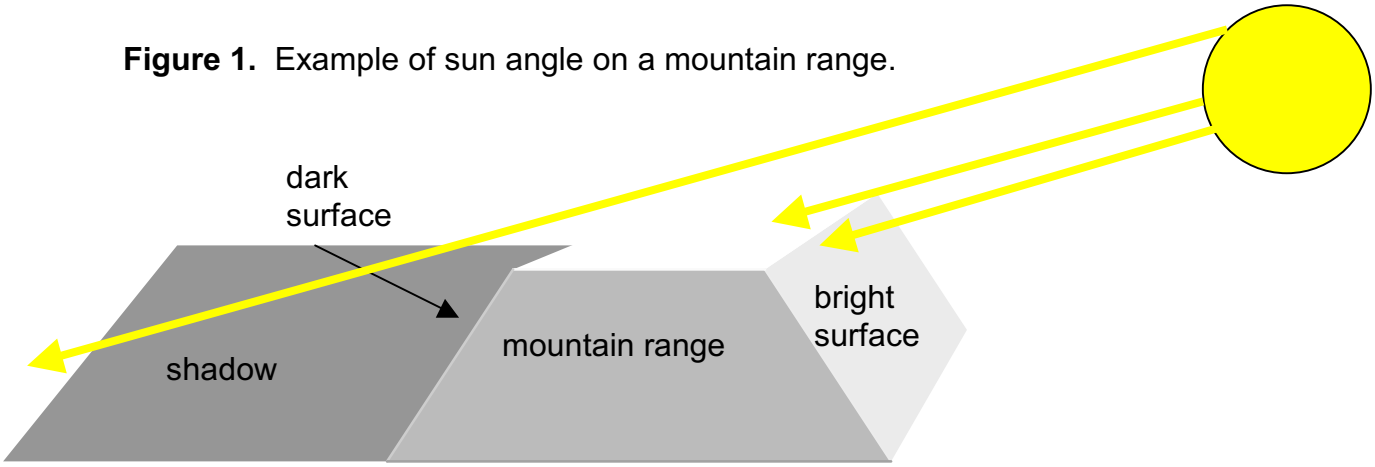
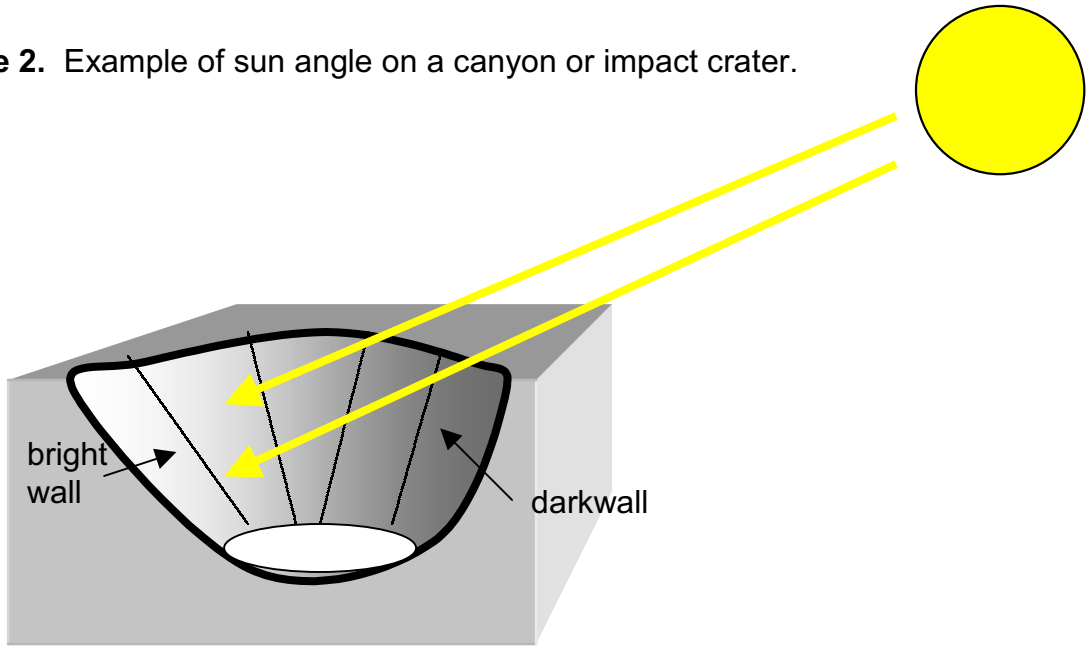


Figure 2. Example of sun angle on a canyon or impact crater.



Procedure:
In this lesson students will practice interpreting images and naming the features they see.

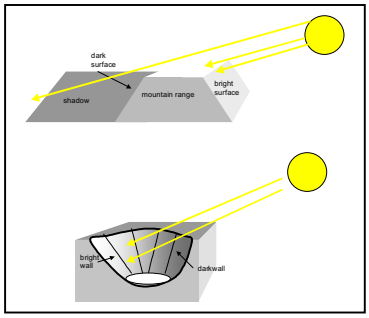
1. Display O*verhead 1* and discuss how sun angle is used to interpret features in images.
2. Display *Overheads 2-5*, in order, and do the following for each:
   - Explain that these are images of the surface of Mars taken by a camera onboard a spacecraft.
   - Ask students what they see in the image.
   - Discuss how lighting is important and how it is pronounced on certain features. Tell students the position of the sun in each image.
   - Discuss shadows and shadow lengths based on position of the sun.
   - Ask students what features they now see.
   - Some overheads have questions. Cover up the answers until needed.
   - Continue discussion until the class can demonstrate the concept of visualizing a 2-dimentional black and white image as a 3-dimensional surface.

Assessment:
Pass out Student Sheet to be completed as a graded assignment.

Vocabulary:
Remote sensing, high-resolution, pixel, digital image

Additional Resources:
http://www.spacegrant.hawaii.edu/class_acts/DNImagesTe.html
http://teacherlink.ed.usu.edu/tlnasa/units/PlanetaryGeology/23.pdf

Overheads

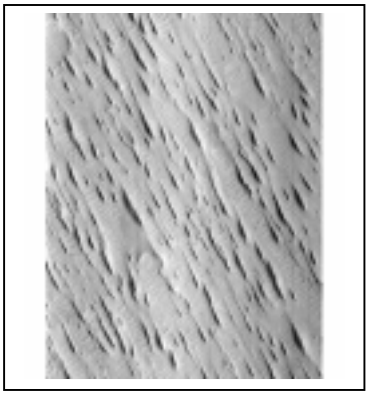


Overhead 1. Concept of sun angle on features.

Overhead 2. Observation of geologic features in a region.

Overhead 3. Mesas and buttes with dunes at their bases.

Overhead 4. Channel intersection.



Overhead 5. Eolian/wind processes and resulting landforms.